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ABSTRACT

This study tested for the existence of neighborhood effects on end of school educational attainment some 2,500 urban youth who left school between 1984 and 1986 in one educational authority in Scotland. Data were drawn from a student survey and from the United Kingdom 1981 Census of Population. A hierarchical linear regression model was used to test for neighborhood effects and to estimate the contribution of neighborhood deprivation to those effects. After controlling for pupil ability, family background, and school-level variables, the study found a significant negative association between deprivation in the home neighborhood and academic achievement together with additional neighborhood effects which could not be explained by the model. Statistical data are included on two tables and two graphs. A list of 41 references is appended. (FMW)

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Educational attainment: A multi-level analysis of the influence of pupil ability, family, school and neighbourhood

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ABSTRACT

This study tested for the existence of neighbourhood effects on end of school educational attainment among some 2,500 young people who left school between 1984 and 1986 in one educational authority in Scotland. The study linked survey data with area data from the UK 1981 Census of Population and used hierarchical linear regression modelling to test for neighbourhood effects and to estimate the contribution of neighbourhood deprivation to those effects. Given control for pupil ability, family background and schooling the study found a significant negative association between deprivation in the home neighbourhood and educational attainment together with additional neighbourhood effects which could not be explained by the models.

The findings suggest that policies to alleviate educational disadvantage cannot be focused solely on schooling but must have a broader remit of tackling social deprivation in society at large.

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INTRODUCTION

A recent report to the Department of Education and Science in London by management consultants Coopers and Lybrand states that "... there has been no definitive research which establishes a clear relationship between measures of deprivation and the need for educational resources" (Coopers and Lybrand 1988 para 3.16). We believe that the study reported here provides just that.

One of the most intractable problems in the study of the relationship between deprivation and educational attainment has been the inability to disentangle the separate and joint effects of a large number of different factors influencing attainment, making up what the Plowden report in the 1960s aptly called "...that seamless web of circumstance ..." (CACE, 1967). It is well known that pupils from socially deprived areas have on average lower educational attainment than their counterparts from more advantaged areas (Coleman *et al.* 1966; CACE 1967; Rutter and Madge 1976; Rutter *et al.* 1979). What is not known is the extent of the *direct* effect of living in a socially deprived area over and above other factors of influence such as individual ability, family circumstance and schooling. In the present paper we have two aims. First we attempt to show whether there are 'area' or 'neighbourhood' effects on attainment and second we examine the importance of multiple deprivation in contributing to any such neighbourhood effects.

Using data on some 2,500 young people who left school between 1984 and 1986 in one education authority in Scotland, we examine the contribution of individual ability, family background, schooling and neighbourhood to young people's end of school attainment. This study extends an earlier analysis based on school leavers from Glasgow schools in 1979/80 which showed that there was additional detriment to young people's attainment from living in areas of social deprivation (Garner 1988). The present study overcomes two important limitations which were indicated in that earlier study. First, we have a more fully specified model because we can include a measure of individual attainment at primary school. This acts as a reasonable proxy

for pupil ability. Second, we have used a multi-level modelling technique which gives more accurate results than traditional methods in the analysis of hierarchical data and additionally permits the estimation of effects between levels.

Neighbourhoods and Neighbourhood Effects

Neighbourhoods and neighbourhood effects can be conceptualised in many ways. The neighbourhood has always been an important unit of spatial aggregation for studying social interactions and the aetiology of social problems (Smith 1980). However, there is no single, ready-made definition of what constitutes a neighbourhood. Neighbourhoods are not uni-dimensional, spatial units but vary in their definition depending on the type of problem to be studied, the supposed relationship between the neighbourhood characteristics and the phenomenon under study and the conceptualisation of the structural effects of neighbourhood. There is evidence to show neighbourhood or locality effects on such phenomena as urban crime and deviant behaviour (Herbert 1976), voting behaviour (Johnston 1976), morale of the elderly (Lohmann 1980; Bohland and Herbert 1983), mental health (Smith 1980) and child abuse and neglect (Gabrino and Crouter 1978, cited in Smith 1980).

Neighbourhood influences on educational attainment are likely to be through the social characteristics of the neighbourhood rather than the physical environment, although it is also likely that the residential environment will interact with the social structure to confound individual or family level influences. The neighbourhood contextual effect on educational attaiment can be supposed to result from a variety of processes as varied as individual personality development to built-form determinism. These influences can be divided broadly into three groups. First, psychological studies have shown that some types of residential environments are associated with particular personality characteristics, which may result in individuals responding differently to education depending on their environment (Butcher, Ainsworth and Nesbit 1963; Moulden 1980). Similarly, education being essentially an individual experience, is

thought to assume less importance to individuals who live in areas where adherence to group norms is of overwhelming importance in terms of social cohesion (Robson 1969). Second, several studies have pointed out that the interactions afforded by the local physical environment in terms of child-child, child-adult or even adult-adult contacts may influence attainment through such factors as language development (Bernstein 1971), peer-group pressures (Kelsall and Kelsall 1971) or the development of parental attitudes to education (Robson 1969). Third, economic pressures may be associated with poor health, material and experiential poverty and the pressure to leave school early. Although such economic pressures are essentially individual or family influences, the concentration of families suffering individual deprivations in specific localities, such as run-down local authority housing estates, is felt to predispose individuals in those areas to feel a sense of futility and hopelessness. In relation to education, the Plowden report highlighted the problem of educational relevance to future life in areas of predominantly manual employment:

> "... in a neighbourhood where the jobs people do and the status they hold owe little to their education it is natural for children as they grow older to regard school as a brief prelude to work rather than as an avenue to future opportunities (CACE 1967, p. 50)".

These effects are all something more than just an aggregation of individual characteristics. They are area effects.

STUDY DESIGN: SPECIFICATION AND METHODS

In testing whether area effects exist, through whatever mechanism, we must be severe in our specification of the model of individual-level influences on attainment. A rigorous specification of the individual-level model must be made to counter Hauser's argument that effects from groupings at a higher level are no more than artefacts of poorly specified individual-level models (Hauser 1970). The data requirements and the methodology to produce such an adequate specification are demanding. However, we can be guided by recent school-effectiveness research

where thinking on these problems is most advanced. A detailed discussion can be found in Willms (1987) but may be briefly summarised as follows. First, because educational attainment is an individual characteristic, it is essential to measure attainment at that level, to use aggregate and average outcomes could be misleading. Second, adequate control for "intake" must be built into the analysis to reduce selection bias and to ensure that effects which any model may attribute to higher-level units, such as neighbourhoods, are not simply a consequence of the different types of individuals within those units (Hauser 1970). Third, conceptual and statistical models must allow for the multi-level structure of the real world and the relational nature of that structure (McPherson and Willms 1986). Data limitations have frequently resulted in an abandonment of the first two principles although we are able to meet both requirements in the present study. The third principle however, is one which has only recently become tenable with the development of software to permit a multi-level statistical analysis of large data-sets.

Although conceptual models have recognised the multi-level structure of society for many years (Blau 1960; Byrne, Williamson and Fletcher 1975; Ebring and Young 1979) the statistical software to estimate such models has only become available since the mid-1980s. Multi-level regression is a relatively new approach in the modelling of social data. It is similar to an analysis of covariance (ANCOVA) but where ANCOVA typically has a small number of treatment groups, multi-level modelling can accommodate hundreds of higher-level units. Multi-level variance components analyses have been extensively used in the natural sciences (Robinson 1987) but within the social sciences, educational research has provided the main thrust for development (Aitkin and Longford 1986; Goldstein 1986, 1987; Raudenbush and Bryk 1986; Willms 1987, 1988). The stimulus for development in educational research comes from the fact that key independent variables are often measured at a higher level of aggregation than the outcome variable of interest. For example, an important research question may be how pupil attainment is affected by school-level

expenditure. The current software was developed because of an awareness of the limitations imposed on the analysis of multi-level data by inappropriate methods (Burstein 1980) and the restriction on data-set size imposed by readily available packages (Aitken and Longford, 1986).

These hierarchical modelling programs make three important contributions to the analysis of social-scientific data with a nested structure. First, because these models explicitily recognise the clustering of individuals within higher-level units, such as schools, they avoid violating the assumption of independence of observations which traditional OLS analysis commits in analysing hierarchical data. Second, hierarchical models are powerful in estimating cross-level effects. Because they can model the outcomes of the lower level, (within-unit) model by variables at a higher level, they can assess the influence of higher-level variables not only on mean outcomes at the higher level (the intercepts of the within-unit models) but also on the structural relationships between the outcome variable and lower-level background variables (the slopes of the within-unit models). For example this ability allows us to assess how the level of school expenditure affects mean attainment in the school, and how it affects say the relationship between social class and attainment within schools. Such a model would be able to assess the success of compensatory policies for the most needy pupils in schools. Third, hierarchical models can partition the variance between levels and can statistically separate the parameter or 'true' variance in the slope parameters of the within-unit model from sampling variance. Not only does this allow us to estimate the contribution which schools make to pupil attainment but this has significant implications for the estimation of higher-level effects. These effects have frequently been dismissed in studies as being unimportant because they may explain only a small amount of the observed variance. However, if the total observed variance, contains a large amount of sampling variability which is essentially unexplainable, we should be estimating only the proportion of true or parameter variance which can be explained by higher level factors and this might be considerable.

STUDY DESIGN: DATA SOURCES

The data used in this study come from four sources. The individual and family background characteristics come from a 95 per cent sample survey of pupils in one Scottish education authority who were in their last compulsory year of schooling (S4) in the session 1983-84. This survey is one of a series of surveys of young people (Scottish Young People's Surveys) conducted by the Centre for Educational Sociology at the University of Edinburgh in conjunction with the Scottish Education Department and other funding bodies. Additional individual level attainment measures were obtained from the Education Authority (EA) providing a measure of pupil attainment prior to entry to secondary school. Scottish Certificate of Examination (SCE) results for the two years of non-compulsory schooling (S5 and S6) were obtained from the Examination Board.

The fourth source of data is the 1981 Census of Population.[1] Data at the level of the enumeration district (ED) were combined into a deprivation score as devised by the Housing and Urban Renewal Research Unit of the Scottish Development Department (Duguid and Grant 1983). This score and neighbourhood membership were allocated to individuals through the postcode of their home address (Garner 1984).

The data set was restricted to include only those young people who were living in EDs in urban areas. The urban categorization is defined as those EDs which are in continuous urban areas of over 10,000 people as defined in the 1981 Census. The focus on the effects of urban neighbourhoods and their level of deprivation was felt to be justified, given the different nature of deprivation in urban and rural areas (Shaw 1979). This difference can be seen in the average scores on the deprivation index which range from −0.44 in rural areas to −0.12 in urban districts of the present study area (the more positive the deprivation score the more deprived the area).

The resultant data set is however problematic for multi-level analysis because of

its non-hierarchical structure. Neighbourhoods (EDs) can send pupils to more than one school and because at present the software requires a strict hierarchy where neighbourhoods, schools and individuals would nest one within the other, without crossing between levels, we had to adopt an alternative working strategy to allow us to proceed with the analysis. The best solution to this problem would be to cross-classify neighbourhoods and schools but the software is only currently being developed to allow this cross-classified analysis for large data sets (Goldstein 1987). The most practical solution was to restrict the analysis to two-levels (see below) with a final data set of some 2,500 individuals, 17 schools and over 500 neighbourhoods. Two sets of analyses were conducted on these two-level datasets. First, a series of models were fitted taking neighbourhood as the higher-level unit and including school membership at the individual level. Second, a series of models with schools as the higher-level units and neighbourhood deprivation scores at the individual level, were also fitted.

MEASURES AND DEFINITIONS

The outcome measure is a general attainment score at completion of secondary school. The scale has 14 categories describing the number of O-grade and Higher SCE awards at the A to C level. Awards on the range A-C are officially recognised as passes on the SCE Highers examination. For pupils obtaining no A to C, O-grade awards, account was taken of any SCE O-grade awards at the D or E grade. This variable captures both attainment and length of schooling since Highers cannot be taken until fifth or sixth year, that is in the first or second year of non-compulsory schooling. This variable was scaled using a logit transformation for re-expressing grades (see Willms 1986).

The independent variables were chosen partly to replicate, but also to extend earlier analyses (Garner 1988). The specification of the model at the individual pupil level was made as full as possible to construct the most stringent test feasible on the contribution of neighbourhood and neighbourhood deprivation. The most important of

these personal/family variables are the prior-attainment measures. These variables fill an important gap in the earlier analysis of Glasgow school leavers.

Individual Measures

The prior-attainment measures were obtained from the EA. Two test results are included here, a measure of verbal reasoning ability (Godfrey Thomson Unit 1973) and a test of reading ability. These are outcome measures on tests administered to all pupils aged between eleven and twelve years in EA primary schools.[2] The variables are standardized and centred around the mean for the study area prior to the analysis. These measures are themselves educational outcomes, therefore as well as measuring innate ability, they will capture some of the influence of family, school and neighbourhood which have been brought to bear on a child's educational performance up to the time when the tests were administered. Without such measures in the model we would be in danger of not controlling for selection bias in the higher level units. However, by including them we are certainly underestimating the *total* effects of family, school and neighbourhood influences. Given this control in our model, the educational outcomes which we are predicting represent only the progress in educational performance which occurs in secondary school between the age of eleven or twelve and the end of compulsory schooling. Such an outcome is crucial if the focus of the study is the effectiveness of secondary schools. However our control of prior-attainment is perhaps too stringent a control for an analysis of the effect of neighbourhood deprivation or family circumstances since it effectively restricts conclusions about the influence of these background factors to the four or so years of secondary schooling.

The only other data measured unambiguously at the level of the individual is sex of respondent. This is coded zero for males and one for females and provides another important individual-level control variable.

Family Measures

Family characteristics which are taken here to be individual characteristics are in a sense, wrongly attributed to that level since they are more correctly properties of the group of individuals which make up the family and could therefore be taken to constitute another level in the model. There are six family measures included in our models in the present study. First, father's occupation, which acts as a proxy for social class, is scaled on the Hope- Goldthorpe scale in conjunction with the Registrar General's social class index (Willms 1986). Length of parental schooling is represented by two dummy variables. These are proxy measures for the level of parental education. They are scaled one for mothers and fathers who stayed on at school beyond 15 years and zero for those who left school at age 15 or earlier or if this information is missing or unknown. A discrete interval level variable represents family size as a count of the number of siblings for each respondent. It has a range of zero to nine with missing categories excluded from the analysis. Two dummy variables (scaled one/zero) indicating membership of one-parent families and whether father's employment status was non-employed were also included. All family variables were centred around their respective study-area means before the analysis.

These family variables, particularly social class and parental education are conceptually problematic and their validity as 'true measures' can be questioned. However, as indicator measures they are both powerful and essential to any well specified model of filial attainment.

Schooling Measures

The restriction of the study to urban areas reduced the 20 EA schools in the study area to 17. In the first set of models where neighbourhood forms the higher-level unit of analysis the schools are represented by a set of dummy variables. These dummy variables represent school membership and therefore capture all the variation associated with schools whether attributable to processes within the schools or

through their contextual effect. School contextual effects are widely discussed elsewhere (Willms 1985; 1986) but can be summarised as the effect which the pupil membership of a school has on an individual pupil's educational attainment. Given the small number of individuals in each neighbourhood (see below) it is impossible to fit all the school dummy variables and the pupil background variables. To reduce the number of variables, schools were clustered into six groups by fitting a "schools-only" model and grouping schools together using a clustering algorithm based on their unconditional relationship with the outcome variable.

Because these school dummy variables are being fitted at the level of the individual in our neighbourhood models, they will potentially capture part of the neighbourhood effect and part of the effect of neighbourhood deprivation. School catchments and neighbourhoods have a degree of co-linearity because of the essentially local nature of a school's catchment. The overlap between school and neighbourhood is difficult to disentangle in our two-level models and fitting the school variables as individual characteristics will absorb the variation which may be jointly attributed to schools and neighbourhoods. This means that the neighbourhood effects and the effect of neighbourhood deprivation may tend to be underestimated in the neighbourhood models where we include the school variables. In the models where schools constitute the higher-level unit of analysis, neighbourhood deprivation will potentially capture part of the school-contextual effect and therefore we may tend to overestimate the effect of deprivation. The addition of neighbourhood deprivation as an "individual-level" characteristic in the school-level models will however control only for level of deprivation. It will not be able to capture any neighbourhood effects which are not related to deprivation, these are likely to become absorbed into the school effects.

Neighbourhood Measures

Neighbourhoods are represented by EDs from the 1981 Census of Population. Although EDs have entirely arbitrary spatial boundaries as far as educational outcomes are concerned, because we have no firm *a priori* definition of the spatial unit which constitutes a neighbourhood it is perhaps preferable to use spatial data in the most minimally aggregated form available. Aggregation of spatial data reduces variability through averaging and obscures real world differences. Analyses with different aggregations of the same spatial data can produce very different results (Openshaw and Taylor 1981), therefore we must be cautious to choose a spatial unit which represents a reasonable areal scale for the processes which we think might be at work. Our ideas of how area effects might influence attainment would lead us to choose a neighbourhood of a slightly larger spatial scale than an ED. EDs contain only 150-200 households and are likely to be too small to represent the type of area effects which we hypothesize. However, it is well known that ecological correlations generally become weaker the smaller the areal grouping examined, which means that by choosing EDs we are again constructing stringent tests for neighbourhood effects and the effect of neighbourhood deprivation. If we can illustrate effects using this small-scale neighbourhood unit, it should make us more confident in the validity of our results. The school-level analysis will provide a further test of the validity of our findings with respect to deprivation.

EDs therefore are taken to form the higher-level units in the first set of analyses and additionally each ED is allocated a deprivation score based on an algorithm devised by the Urban Renewal Research Unit of the Scottish Development Department (Duguid and Grant 1983). This score is a combination of twelve variables from the 1981 Census of Population (Table 1). The most heavily weighted constituents of the index are: unemployment, youth unemployment, single-parent families, low-earning socio-economic groups, overcrowding and the percentage of permanently sick. This combination provides a sensitive measure of the level of disadvantage in the home

neighbourhood and permits an estimation of the influence of social deprivation, as distinct from any other neighbourhood effects, on educational attainment. The score is designed to have a mean of zero and a standard deviation of one for the whole of Scotland. The present study area has a mean deprivation score of -0.108 with a standard deviation of 0.620. This means that the urban areas of this education authority are less deprived than the average for Scotland and have a narrower range (i.e. are more homogeneous) than the country as a whole. In the analysis performed at the school-level it is this deprivation score which provides the only representation of neighbourhood, although a mean deprivation score for each school's catchment provides an additional school-level variable.

METHOD AND STRATEGY FOR ANALYSIS

Both sets of analyses use the HLM program (Bryk, Raudenbush, Seltzer & Congdon 1986) to fit a series of multi-level models. This program represents an hierarchical two-level model by two equations which are estimated simultaneously, the within-unit and the between-unit equations. The first within-unit model here, regresses individual educational outcomes on prior attainment, sex, family background and schooling variables within each neighbourhood, while the between-unit model, at the neighbourhood level, models parameters (intercepts and slopes) from the within-unit equations as a function of the neighbourhood deprivation score.

In the second series of models where school forms the higher-level, the within-school model includes identical individual-level variables to the neighbourhood model together with the deprivation score for each individual's home neighbourhood as an individual-level characteristic. The between-school models include contextual variables aggregated up from individuals to give mean school characteristics.

Following the notation of Raudenbush and Bryk (1986) the within-unit, pupil level model for neighbourhoods can be written:

$$Y_{ij} = \beta_{j0} + \beta_{j1}X_{ij1} + \beta_{j2}X_{ij2} \cdots + \beta_{ijk-1}X_{ijk-1} + R_{ij}$$

where

Y_{ij} is the educational outcome for individual i ($i = 1 \ldots n_j$) in neighbourhood j ($j = 1 \ldots J$);

there are $k=1, \ldots k-1$ independent variables X_{ijk} which represent the individual's characteristics, and family background variables and school membership;

β_{jk} are the within-neighbourhood regression coefficients;

R_{ij} is the random error term or unique contribution of each individual i in neighbourhood j.

The between-unit model (ie neighbourhood level) can be written:

$$\beta_{j0} = \theta_{00} + \theta_{01}D_j + U_{j0}$$

where

β_{j0} is an estimate of how well a young person with average individual, family and school characteristics performs in each neighbourhood or in other words an estimate of the variation between neighbourhoods in their adjusted levels of performance.

D_j is the deprivation score for each neighbourhood;

θ_{01} is the regression coefficient for the effect of neighbourhood- deprivation on the adjusted neighbourhood attainment;

U_{j0} is the neighbourhood-level error term (posterior means) or the unique contribution of each neighbourhood - the neighbourhood effect.

Additionally we could write further neighbourhood-level regression equations which model each of the remaining within-neighbourhood regression coefficients as a function of the neighbourhood deprivation score if the slopes were allowed to vary between neighbourhoods. The school-level models have similar notation.

ANALYSIS AND RESULTS

Neighbourhood Models

Table 2 presents a summary of the series of neighbourhood HLM models fitted to the data on educational outcomes. The first model fits only an overall constant to the data. This is equivalent to performing a random effects analysis of variance and allows us to calculate how much of the variation in individual educational outcomes lies between neighbourhoods. [3] In the present study 18 per cent of the unconditional variation in educational outcomes is between neighbourhoods. This is the variation in attainment between neighbourhoods before controlling for any individual background variables.

Model 2 fits a constant plus the individual and family background characteristics. All variables are fitted as fixed effects which means that their relationship to attainment is constrained to be the same (i.e. the slopes are identical) for each neighbourhood. Exploratory analyses showed little heterogeneity in the slopes of background variables on attainment between neighbourhoods. Because we are essentially focusing on the 'neighbourhood' effects while controlling for other factors of influence on attainment it is quite appropriate to fit these variables as fixed effects. This model explains some 32 per cent of individual variation in educational outcomes and virtually all the true (parameter) variance in educational attainment between neighbourhoods. However, that left unexplained by individual characteristics remains statistically significant and although the remaining variation appears to be a small amount, (one per cent) the magnitude of that remaining, is only slightly less than estimates for variation remaining between schools in other similar cross-sectional analyses (Willms 1987).

The very large contribution of the prior-attainment measures in explaining educational outcomes at the end of compulsory schooling is not surprising and has been seen in other studies of similar data (Willms 1986; 1987). That it also explains

such a large proportion of the variation between neighbourhoods may be partly due to the small sample sizes within neighbourhoods. This means that the intra-neighbourhood correlations are small and that a large proportion of the between-neighbourhood variation is contributed by the within-neighbourhood variation. For example in the extreme case where there is only one individual in a higher level unit (neighbourhood) the within-neighbourhood variation is totally confounded with the between-neighbourhood variation and no separate estimates are possible (Goldstein 1987). As we get more higher level units with fewer individuals within them we begin to approach the situation of a single level analysis, and indeed OLS regression estimates become more reliable under these circumstances. The statistical significance of any neighbourhood effect however, relies more on the number of neighbourhoods than on the number of individuals within them (Raudenbush and Bryk 1986) therefore we are erring on the side of statistical safety using EDs rather than some other arbitrary larger-scale spatial grouping.

Given that our prime interest is in assessing the contribution of processes which are occurring at the neighbourhood level after we have controlled for individual-level variation, we take this model (Model 2) as our base model for comparative purposes. Model 3 adds school groups at the individual level and, the deprivation score at the higher level. None of the school groups contribute to the explanation of variations in educational attainment between neighbourhoods, therefore they can be dropped without detriment to the fit of the model leaving the final best-fit model as Model 4. This does not mean that schools are unimportant in terms of contributing to variations in attainment but at the neighbourhood level (ED) we do not have sufficient variability in schooling or power in the data to detect school influences. This is a problem of attenuated variance at the neighbourhood level. The small number of observations within each ED and the fact that in many neighbourhoods all pupils attend the same school means that there is a degree of co-linearity between schools and neighbourhoods. This is reflected in a comparison of the coefficients in Models 3

and 4 which show virtually no change for the individual and family variables when schools are removed from the model but an increase in the coefficient for neighbourhood deprivation, at the neighbourhood level. This coefficient shows the importance of neighbourhood deprivation in explaining the mean neighbourhood attainment (intercept) given that we have controlled for individual and family background. Deprivation explains around 20 per cent of the unexplained neighbourhood variation. The remaining unexplained variation in the model remains statistically significant which means that there are processes affecting educational attainment at the neighbourhood level which we cannot capture with our existing model.

If we examine the parameter estimates from Model 3 or Model 4 we see that at an individual level, those young people whose fathers are in higher social class groupings have a positive advantage for their educational outcomes. Mother's and father's education beyond 15 years also has a substantial positive effect on educational outcomes. Father's education is marginally more important, but mother's education has a strong positive effect independent and additive of father's education. For children's attainment the added advantage of each parent being educated beyond 15 years is approximately equivalent to one additional O grade pass at A-C. Being a member of a large family or coming from a single parent family or a family where the father is currently unemployed all have a negative effect on attainment, although father's current employment status is not statistically significant and was dropped from the final model (Model 4). Being female has a positive effect on secondary school attainment however, the most important predictors of attainment at school-leaving age are the measures of prior attainment at the age of twelve.

The parameter estimates for the deprivation score show that deprivation in the home neighbourhood has a negative association with educational attainment even after stringently controlling for variability at the level of the individual. For two pupils with identical prior-attainment scores and family background characteristics, attending

the same school, the differences in their educational outcomes associated with differences in neighbourhood deprivation may be greater than 1 O-grade pass (this is the difference associated with a change in the level of deprivation from the 10th to the 90th percentile in the present study area). Further real world examples will help to illustrate that although the total variation in educational outcomes to be explained by neighbourhood deprivation appears small the deprivation effect is not trivial. School catchments vary considerably in terms of their average levels of neighbourhood deprivation. For example in the education authority under study, one school has an average catchment deprivation of +0.377 while another school has an average of -0.492. A difference of this magnitude in the level of deprivation gives a predicted attainment differential, for two pupils who are otherwise identical, of up to one O grade pass at A to C.

Average catchment scores obviously obscure the variation within any one school catchment. Figure 1 illustrates that not only do schools vary in their average levels of deprivation but that the range of intakes may also vary. In school number one for example three pupils come from a neighbourhood (ED A) with a deprivation score of -0.584 while six pupils come from a neighbourhood with a score of +0.385 (ED B). If these pupils have identical profiles on prior-attainment and family background variables then the model would predict that the three pupils from neighbourhood A would have attainment scores of 0.09 of a standard deviation higher than the six pupils from neighbourhood B. This is almost equivalent to an extra O grade award at A to C and is the differential associated solely with neighbourhood deprivation. Other schools show greater differentials, with the maximum predicted differential being greater than two O grades. All other factors are held constant and assumed to be equal, which clearly they are not. Young people who live in socially deprived areas are more than likely to be multiply deprived, first through their home circumstances, second through where they live and third through the "contextual" effect of their schooling. It should be remembered also that the deprivation effect which we are

measuring here is one which has had the effect of deprivation on attainment before the age of twelve removed. The prior-attainment measures are likely to incorporate deprivation (and many other) effects from earlier childhood and we are therefore being conservative in our estimates of the magnitude of the deprivation effect. We are essentially measuring the effects of neighbourhood deprivation (and other background factors) on attainment solely during the period of secondary schooling.

SCHOOL-LEVEL MODELS

Table 3 summarises the school-level models fitted to the 17 schools in the urban areas of the study. In these models, neighbourhood effects are restricted to the influence of deprivation as an individual-level variable. This means that essentially we are ignoring the clustering of individuals within neighbourhoods and may be biasing our estimates of the deprivation coefficients. A similar series of models to those for neighbourhoods is fitted. The random effects ANOVA model (Model 1) allows us to estimate that some nine percent of the unconditional variation in educational outcomes is between schools. This is lower than found in other studies of similar data, however we have a restricted subset of schools with no schools serving rural areas. The lower variability between schools than between neighbourhoods is partly due to differences in levels of aggregation. Schools are larger aggregations of individuals therefore there is likely to be a greater variability within schools than within neighbourhoods and correspondingly less variation between schools. Model 2, again provides our base for comparative purposes. Neighbourhood deprivation is introduced as an individual-level variable in Model 3. This is problematic for interpretation because we must introduce deprivation, allowing the slope to vary between schools (a random effect). This requires that the variable is centred around its mean for each school and that mean level of deprivation for the school is introduced at the school level to avoid mis-interpretation of the effect.

The coefficient for the "average" effect of deprivation within schools is very much larger than the coefficient obtained from the neighbourhood model as can be seen

from the predicted attainment differentials within schools shown in Figure 2. The doubling of the coefficient for neighbourhood deprivation in the school-level models may be because of bias introduced by ignoring the clustering of individuals within neighbourhoods but it may also be because neighbourhood deprivation here is capturing part of the school contextual effect. In the school-level models the deprivation score of each ED, because it is attributed to individuals, is taken to have the same relationship to attainment for all individuals in an ED although its effect is allowed to vary within schools. Obviously the ideal situation would be where the relationship could vary both within neighbourhoods and schools. Taking the two sets of analyses together leads us to the conclusion that both neighbourhoods and schools must be taken into account in examining educational disadvantage.

Mean level of deprivation at the school-level is not statisticaly significant in predicting variability between the intercepts for schools although when fitted in a model where the deprivation effect is constrained to be the same within each school it has a significant and positive effect on mean school attainment. This, together with the small positive (all be it non-significant) effect found here provides some evidence to support the fact that compensatory policies in schools with high levels of deprivation are having an ameliorating effect on pupils' attainment in those schools.

The interpretation of this model however remains problematic since we are attributing an area variable to individuals. The school-level analysis was performed as a cross-check to the analysis in the neighbourhood models. The fact that deprivation retains its significant negative association with attainment makes us more confident that we have evidence of a neighbourhood deprivation effect.

SUMMARY AND DISCUSSION

We are now in a position to reflect on how well we have established that there are neighbourhood and neighbourhood-deprivation effects on educational attainment. By using the new technique of hierarchical linear modelling we have been able to

show that there is a substantial variation in educational attainment between neighbourhoods but that when we control for prior attainment and family background we explain almost all of that variation. We argue however that by controlling for pupil-attainment at entry to secondary school we are underestimating the total effect of neighbourhood deprivation on attainment. The unexplained variation is statistically significant and important. Although it appears a small amount, this should not be interpreted as being unimportant (or impossible) to tackle through policy initiatives. An important amount (20 per cent) of the remaining variation between neighbourhoods was explained by neighbourhood deprivation. Even with our extremely stringent individual-level specification the predicted variations in educational attainment which are associated with neighbourhood deprivation (*ceteris paribus*) may be greater than one O grade at A-C. This may seem trivial but it must be remembered that this effect is additional to the effects from individual and family background influences and when translated into employment prospects, may be of real significance in determining the future life-chances of young people. We should also remember that the present study area has on average a lower level of deprivation than the average for Scotland and is more homogeneous. The effect of neighbourhood deprivation in some of Scotland's more deprived local-authority housing estates in the cities of Glasgow and Edinburgh will be correspondingly greater.

The negative association of deprivation with educational outcomes highlights a real cause for concern. Targetting schools in socially deprived areas will alleviate some educational disadvantage, however, tackling the social deprivation itself, in such areas would also have a substantial effect. The use of HLM allowed us to show that the variation between neighbourhoods left unexplained by neighbourhood deprivation is also statistically significant and substantively important suggesting that there are processes working at the neighbourhood level, contributing to attainment which we are unable to explain by our existing model and which require further investigation.

This was despite the small scale areal units which we were taking to represent neighbourhoods in the present study.

By running comparable analyses at a school level we were able to get some estimation of the deprivation effect within schools. This two-way estimation allows some notional "confidence intervals" to be placed around the deprivation effect, although ideally we look forward to the time when the software will be available to permit a cross-classified analysis of schools and neighbourhoods.

The findings here have crucial importance in at least two areas where policy changes are currently being proposed. First, in the area of measuring school effectiveness and the proposed introduction of national testing and school performance indicators (Black 1988), where it is clear that local deprivation and neighbourhood effects have an important association with educational outcomes and should be taken into account. If schools are assessed with only some vague attention being paid to catchment characteristics then the judgement of school performances will be flawed. To totally ignore the wider socio-economic structure in which the school is situated, as proposed recently (Mortimore 1988; Wilby 1988) would lead to gross misinterpretation (Willms 1987; Goldstein and Cuttance 1988). To take account of it, as some vague "average" for some increasingly "vague" catchment[5] would be potentially as dangerous. If policy-makers and assessors are determined to measure school performance they must follow Willms' plea for rigorous model specifications improved data, and correct statistical analyses (Willms 1987), otherwise they will only serve to mislead and confuse.

Second, findings here should prove of interest to policy makers who are addressing the problem of educational disadvantage. The present study has not been able to further either the conceptualisation or the theoretical understanding of the process of educational disadvantage. What it has achieved is a contribution to the developing theory of educational attainment. We have reinforced the knowledge that

the sources of educational disadvantage are not singular. They are multivariate and they are multi-level. We have been able to provide an illustration of the potential of multi-level analysis for future investigations in this area. By using appropriate individual-level data in conjunction with area-based data and by taking account of this structure in a multi-level analysis we have been able to show the potential for answering long standing questions relating to educational performance. We have only begun to disentangle the influence of neighbourhoods and social deprivation on attainment. The effects we have shown here need to be subjected to more detailed analysis. It may be that by combining the various area-level variables into a single index of deprivation that we have conflated opposing effects on attainment. More work is needed to investigate the influence of specific area-level variables on educational attainment.

Much more also needs to be done to examine the effect of social deprivation on children's attainment through time. We examined the effect during the years of secondary schooling but it may be assumed from other studies that much of the effect will be on younger children and therefore masked here by our primary school attainment measures. These more detailed studies are essential pre-requisites to the successful development of policies to alleviate educational disadvantage.

NOTES

1. The Small Area Statistics for the 1981 Census of Population are made available to researchers through the Edinburgh University Data Library. Copyright of these data is vested in HM Stationery Office on behalf of the Crown, and may not be reproduced without permission. The data were accessed through the computer package SASPAC. Edinburgh University Data Library also provide access to the Postcode Directory for data linkage via software written and maintained by them.

2. The prior-attainment variables are outcomes on the Moray House Verbal Reasoning Test and Reading tests (Godfrey Thomson Unit, 1973). The timed group test (45 minutes) includes 100 items.

3. The variation between neighbourhoods (the intra-class correlation) is calculated using the formula:

   $\hat{\rho} = \tau/(\tau + \sigma)$

   which is equivalent to: between group variance/between group variance plus the within group variance.

   From this model we get the following estimate:

   0.1852/(0.1852 + 0.8450)
   = 0.1852/1.0302
   = 17.98%.

4. Scaled TOTSCEP values with their equivalent qualification levels:

-2.03	'No awards'
-0.63	'O grade D or E'
-0.24	'1 O grade A to C'
0.08	'2 O grades A to C'
0.31	'3 O grades A to C'
0.51	'4 O grades A to C'
0.67	'5 O grades A to C'
0.85	'6 O grades A to C'
1.08	'1 Highers pass'
1.35	'2 Highers passes'

1.64	'3 Highers passes'
2.04	'4 Highers passes'
2.76	'5 Highers passes'
4.41	'6 Highers passes'

5. Parental choice of schooling has meant that school catchments can no longer be defined in "de-jure" terms on a map. "De-facto" catchments may have dramatically different spatial and social characteristics from those originally designed by the education authority.

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Table 1 Deprivation score: constituent variables

Socio-demographic indicators:

1. Single-parent families - households containing at least one single-parent family with dependent child(ren) as a percentage of all households
2. Large households - households with four or more children as a percentage of all households
3. * Elderly households - households containing persons of pensionable age only as a percentage of all households

Economic indicators

4. Unemployment - economically active residents aged 16 or more seeking work as a percentage of economically active residents of the same age
5. Youth unemployment - economically active residents aged 16-20 seeking work as a percentage of economically active residents aged 16 or more
6. The permanently sick - residents aged 16+ who are permanently sick as a percentage of all residents aged 16+
7. Low earning socio-economic groups - residents economically active or retired who are classified by the Registrar General into socio-economic groups 7, 10, 11, 15 or 17 as a percentage of all residents who are economically active or retired

Housing indicators

8. * Amenity deficiency - households without exclusive use of either a bath or an inside WC or both as a percentage of all households
9. Overcrowding - households below the occupancy norm as a percentage of all households
10. * Vacant dwellings - household spaces classified in the Census as 'other' vacants as a percentage of total household spaces
11. * Level and access (1): The very elderly - elderly households containing at least one person aged 75+ on the first floor or above with no lift for access as a percentage of all households
12. Level and access (2): The under-fives - households containing at least one person aged 0-4 on the first floor or above as a percentage of all households.

* these four variables have very small weightings and therefore have comparatively little impact on the deprivation score.

Source: Based on Duguid and Grant (1983)

Table 2

Neighbourhood HLM Models of SCE attainment

Fixed Effects Within-school equations	Model 1 Effect	se	z	Model 2 Effect	se	z	Model 3 Effect	se	z	Model 4 Effect	se	z
Mean attainment	.049	.024	2.02	.060	.025	2.37	.092	.066	1.39	.051	.025	2.07
Prior attainment				.034	.002	14.59	.034	.002	14.19	.034	.002	14.35
Prior reading ability				.023	.002	12.69	.023	.002	12.39	.023	.002	12.51
Sex				.063	.031	2.06	.063	.031	2.06	.064	.030	2.11
Father's social class				.012	.002	8.30	.011	.001	7.63	.012	.001	8.09
Father's education				.147	.044	3.34	.140	.044	3.18	.146	.044	3.33
Father unemployed				-.077	.050	-1.53	-.064	.050	-1.27	-	-	-
Mother's education				.133	.040	3.29	.125	.040	3.93	.128	.040	3.20
Number of siblings				-.067	.011	-5.82	-.062	.012	-5.36	-.063	.012	-5.56
Single parent family				-.122	.046	-2.62	-.104	.047	-2.22	-.104	.046	-2.23
School group attended												
G1							-.129	.175	-.074	-	-	-
G2							-.041	.069	-0.58	-	-	-
G3							-.025	.067	-0.37	-	-	-
G4							-.057	.070	-0.80	-	-	-
G5							.093	.100	0.93	-	-	-
Effects of Between neighbourhood variables												
Deprivation score							-.076	.028	-2.73	-.089	.026	-3.36
Variation Between Neighbourhoods	**Est**	**x**	**df**	**Est**	**x**	**df**	**Est**	**x**	**df**	**Est**	**x**	**df**
Parameter variance	.1852	1106.9	516	.0016	1352.8	516	.0014	1242.2	515	.0013	1245.2	515
Observed variance	.3791			.1761			.1754			.1712		
Reliability	.489			.009			.008			.008		
Model Statistics												
Maximum - likelihood estimate of σ^2	.845			.574			.572			.571		

Table 3

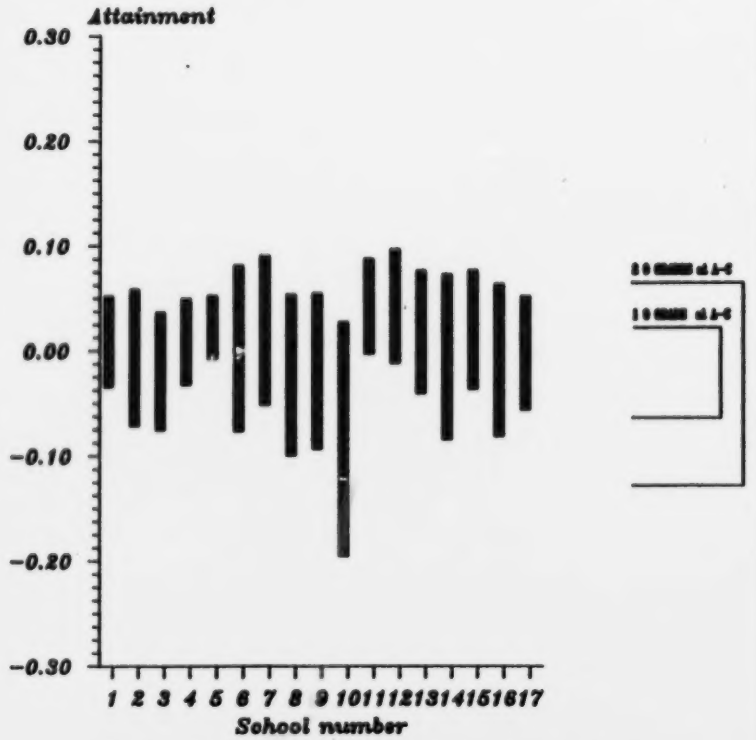
School HLM models of SCE attainment

Fixed Effects Within-school equations	Model 1 Effect	se	z	Model 2 Effect	se	z	Model 3 Effect	se	z
Mean attainment	.021	.076	0.27	-.018	.031	-0.59	-.027	.031	-0.87
Prior attainment				.032	.002	13.12	.032	.002	12.93
Prior reading ability				.026	.002	13.72	.026	.002	13.46
Sex				.059	.031	1.88	.063	.031	2.02
Father's social class				.011	.001	7.35	.009	.001	6.35
Father's education				.204	.046	4.48	.196	.045	4.35
Father unemployed				-.137	.052	-2.65	-.113	.051	-2.20
Mother's education				.111	.042	2.66	.104	.041	2.52
Number of siblings				-.061	.012	-5.26	-.053	.012	-4.54
Single parent family				-.130	.046	-2.85	-.089	.045	-1.95
Neighbourhood deprivation							-.205	.031	-6.50
Effects of Between school variables									
Mean school deprivation							.076	.104	0.73
Variation Between Schools	**Est**	**x**	**df**	**Est**	**x**	**df**	**Est**	**x**	**df**
Parameter variance	.0913	206.68	16	.0044	302.03	16	.0043	312.52	16
Observed variance	.0988			.0099			.0097		
Reliability	.924			.442			.443		
Model Statistics									
Maximum - likelihood estimate of σ^2	.956			.567			.556		

Deprivation Slope		
Est	**x**	**df**
.001	207.78	15
.028		
.023		

Figure 1

Predicted Attainment Differentials by Neighbourhood Model

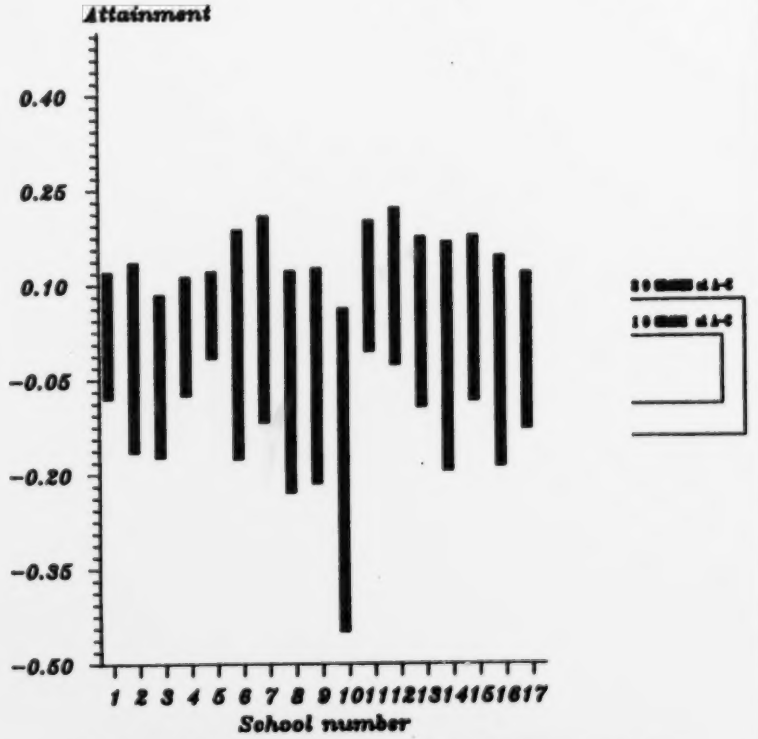


These predicted attainment differentials within schools are those associated with neighbourhood deprivation alone. Individual prior attainment, home background and schooling are held constant. These results are based on the Neighbourhood Model for 17 schools which serve predominantly urban areas.

Designed 1988-08-18 K.R.A.TOLGU

Figure 2

Predicted Attainment Differentials by Schools Model



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